Fermilab

Closeout Presentations

Director's
CD-3b Review
of
the MINERvA Project

June 11-12, 2007

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Table of Contents

Executive Summary 5

1.0 Introduction 7

2.0 Technical 8

2.1 Scintillator Extrusions, WLS Fiber and Clear Fiber Cables (WBS 1, 2 & 4) 8

WBS 1 – Scintillator Extrusions 8

WBS 2 – WLS Fiber 9

WBS 4 – Clear Fiber Cables 10

2.2 PMTs and PMT Boxes (WBS 5, 6 & 7) 8

WBS 5 – PMT Boxes 12

WBS 6 – PMT Procurement and Testing 13

WBS 7 – Electronics and DAQ ..... **Error! Bookmark not defined.**

2.3 Plane Assembly, Outer Detector Frame, Absorbers, Stand and Module Assembly (WBS 3, 8 & 9) 12

WBS 3 – Scintillator Plane Assembly 15

WBS 8 – Frame Absorbers & Stand 16

WBS 9 – Module & Veto Wall Assembly 17

3.0 Project Management 18

3.1 Cost (WBS 10) 18

3.2 Schedule 20

3.3 Management 22

4.0 Charge Questions ..... **Error! Bookmark not defined.**

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Executive Summary

Technical

The MINERvA Collaboration presented the status of the project and their plan for going forward with the Major Item of Equipment (MIE) funded construction activities in FY08. This plan is based on good progress with the R&D activities in FY07 including a Full Module Prototype, fabrication of WLS and Clear Fiber prototypes, receipt of first PMTs, fabrication of 20 PMT Boxes and several hundred optical decoder units (ODUs). One area where additional work is required is on the Clear Fiber cable; the revised production process is expected to be in operation by September.

Design is complete for the Scintillator Extrusion and WLS Fibers and is greater than or equal to 90% complete for the Scintillator Plane Assembly, PMTs, and PMT Boxes. Final drawings are available and support Purchase Orders for the components to be purchased early in FY2008. The schedule for completing design is laid out and the design will be complete in time to support the balance of procurements for the project.

Cost

The current "bottoms up" MIE base cost estimate (supported by updated basis of estimate [BOE] documentation) has modestly increased a net $90K. The R&D total budget profile need has actually gone down ~$250K. This reflects a shortfall of R&D funds in FY2007. This committee recommends that MINERvA show the Total Project Cost (TPC) holding steady to the approved Baseline at ~$16.8M and modify the R&D base and contingency in FY2008 as appropriate.

Schedule

The MINERvA schedule shows CD-4 in September 2010 including 23 weeks of schedule contingency. The critical path on the MIE starts with the receipt and testing of the PMTs and PMT base production, and continues through PMT Box production. Near critical path items are the scintillator plane assembly, the steel frames, modules, and mapping. Good progress has been made on 2007 R&D with ~95% of the Tracking Prototype (TP) scintillator extrusions complete and most other TP systems getting underway.

Due to the congressional continuing resolution in FY07 and late availability of funding, adjustments had to be made in the initiation of several R&D activities with some being moved into FY08. This resulted in losing schedule contingency on much of the R&D,

but it has not yet impacted the MIE projected schedule milestones significantly. The present MINERvA schedule assumes FY08 MIE funding will be available on or before December 1, 2007.

Management

The MINERvA management team is doing a good job executing the project as noted above and in "DOE project space" as described below. There are currently ~30 FTEs on the project; this resource level will average about 35 over life of the project. The only outstanding need identified was for a Deputy Project Manager at or near Fermilab to be named who could stand in for the Project Manager in her absence.

The MINERvA team responded thoroughly to the charge for this review, recommendations from the DOE CD-1/2/3a Review, and the Director's CD-2/3a Review. This committee's response to the charge questions is included in this report. MINERvA provided a comprehensive set of responses documenting how they meet requirements set forth in the CD-3 Scorecard.

The MINERvA management expects to submit a global Change Request reflecting the cost and schedule changes shown here following this Director's Review.

It is the assessment of this Director's Review Committee that MINERvA is ready for CD-3b approval.

1.0 Introduction

A Director's CD-3b Review of the MINERvA Project was held on June 11-12, 2007. The charge included a list of topics to be addressed as part of the review. The assessment of the Review Committee is documented in the body of this closeout presentation.

Each section in the closeout presentation is generally organized by Findings, Comments and Recommendations. Findings are statements of fact that summarize noteworthy information presented during the review. The Comments are judgment statements about the facts presented during the review and are based on reviewers' experience and expertise. The comments are to be evaluated by the project team and actions taken as deemed appropriate. Recommendations are statements of actions that should be addressed by the project team. A response to the recommendations should be discussed at the next monthly MINERvA Project Management Group (MPG) Meeting as part of the preparations for DOE's CD-3b Review. A complete set of responses are to be provided at the next Director's Review.

2.0 Technical

2.1 Scintillator Extrusions, WLS Fiber and Clear Fiber Cables (WBS 1, 2 & 4)

WBS 1 – Scintillator Extrusions

Primary Writer: Jon Urheim

Findings

- Minvera is producing PPO and POPOP doped and TiO_2 coated polystyrene bars using the Fermilab/NICADD extrusion facility.
- Scintillator extrusions have been produced for the Tracking Prototype detector.
- A long production run (one week in duration, done in December 2006) has demonstrated an extrusion rate of 75 kg per hour is achievable over extended periods.
- Due to acceptable quality, a planned iteration on the ID and OD extrusion dies has been deemed unnecessary, saving $77k in R&D costs for this WBS element relative to those given for the DOE CD 2/3a review.
- The QA/QC plan outlined in the Minerva TDR was followed for the production of the extrusions for the Tracking Prototype detector. This includes measurements of bar dimensions and light yield tests with a radioactive source (on one out of 20 bars).

Comments

- The committee commends the Minerva Project for their progress on this system. The cost and schedule for scintillator production for the full detector appear to be under control.

Recommendations

- None

WBS 2 – WLS Fiber

Primary Writer: Jon Urheim

Findings

- Minerva is employing wavelength-shifting (WLS) fiber from Kurary, consisting of multiclad Y-11 doped 1.2mm diameter optical fiber. This fiber is to be inserted into an axial hole in the Minerva scintillator extrusions for light collection and transmission to multi-anode photomultiplier tubes.

- Two thirds of the WLS fiber for the Tracking Prototype detector have been delivered and are undergoing mirroring, which will be complete before the summer 2007 accelerator complex shutdown. The purchase of the remaining one-third of the WLS fiber was delayed due to availability of FY07 R&D funds, and the milestone for completion of this acquisition will not be met. The Minerva team has indicated that this milestone is not on the critical path for on-time completion of the Tracking Prototype detector, and the delay will not have an impact on its cost or schedule.

- Up-to-date quotes and specifications for the WLS fiber are in hand. The first bulk order of WLS fiber is being pre-purchased by the University of Rochester, which keeps this from being on the critical path for the project and mitigates some of the risks associated with reliance on a sole source supplier (Kurary) as well as currency exchange rate variations.

- The Minerva team described two QC procedures that demonstrate the reflectivity variations of the mirrored fiber ends to be within +/- 10%.

Comments

- The committee commends the Minerva Project for its progress on this system. The cost and schedule for WLS fiber procurement, testing, and preparation (mirroring) appear to be under control.

Recommendations

- None

WBS 4 – Clear Fiber Cables

Primary Writer: Jon Urheim

Findings

- This WBS element includes production of custom optical cables, connectors and ODU's (Optical Decoder Units). Some of these items are needed in the production of subsystems that fall under different WBS elements - for example connectors needed for scintillator plane assembly (WBS 3), and ODU's needed for PMT box assembly (WBS 5). Shrouded optical cables are needed at detector installation. ODU's include unshrouded optical cables consisting of 8 fibers with connectors attached at both ends, which are cut in half at the PMT box assembly sites.

- The optical connectors were designed (in conjunction with the CDF plug upgrade) and parts fabricated by Fujikura after adaptation for the 1.2mm fibers used by Minerva.

- The Minerva team has adopted a new polishing technique that reduces the wear on the diamond bit used for this, as indicated in previous reviews. This has led to considerable (~$100k) savings in material and labor. Destructive testing has determined the useful lifetime of these bits, based on information from the standard light transmission QC tests. The QC tests show satisfactory transmission quality of optical cables with polished connectors.

- Production of ODU's for the Tracking Prototype detector is 60% complete. However the rate of breakage of fibers (17% of ODU's affected) during installation in PMT boxes is higher than expected and consequently a larger quantity is needed (543 instead of the original requirement of 440 for the Tracking Prototype detector). This adds $46k to the Project MIE and $44k to the R&D costs for this item relative to the baseline at the time of the DOE CD-2/3a review.

- Installation of connectors on the clear fiber cable involves a light tight molded polyurethane boot that encapsulates the connector/fiber shroud interface. Initial attempts to industrialize this assembly step have encountered setbacks, including (1) incorrect dimensioning of the mold given changes to the optical connector ferrule length, (2) issues associated with the polyurethane pouring process, and (3) related problems with polyurethane flow in the mold and the robustness of mold ejection parts. This has had a major impact on the production schedule of cables for the Tracking Prototype detector. The Minerva team reported that final design and machining of new hardware needed for this assembly step should be complete within the next 4-6 weeks.

- The impact of the delay in clear fiber cable industrialization in terms of cost and schedule have not been fully evaluated. If the new mold hardware functions as

intended, the impact on the Tracking Prototype detector schedule appears to be minimal.

Comments

- The Minerva experimenters have made substantial progress in understanding the technical challenges of production of the clear fiber optical cables.

- The excellent progress on ODU production for the Tracking Prototype detector suggests that cost and schedule for production of this component is well understood.

- The difficulties with production of the shrouded optical cables constitute a source of concern since a final design is not in hand at present. Because the use of a molded boot follows a similar process developed and used for the STAR experiment, the committee believes these difficulties can be overcome.

Recommendations

1. Aggressively review the design for the shrouded optical cable manufacture process once the iteration now in progress is completed.

2.2 PMTs and PMT Boxes (WBS 5, 6 & 7)

WBS 5 – PMT Boxes

Primary Writer: Mike Lindgren

Contributors: Hogan Nguyen

Findings

- The Tufts and Rutgers production factories are essentially complete and final engineering drawings for the phototube mounts are done.
- There have been problems with fiber breakage in assembly into the tube mounts that are being mitigated by increasing the numbers of spare ODUs from 10% to 17%.
- Progress on the test stand was delayed by a student strike at the University of Athens.
- This task is the critical path for the project.

Comments

- The project team continues to make good progress in this area. They have discovered a technical problem that is easily mitigated, and had one schedule interruption due to a student strike that is difficult to plan for. This is the critical path for the project, and care must be taken to make sure that the numerous deliverables that go into the PMT boxes continue to arrive in an unbroken stream when serious production commences. If the opportunity arises to recover some schedule contingency through judicious use of financial contingency that would probably be a good idea. The team has a final design in place, and they know how to do all the steps to produce their deliverable. Construction is the next step, and they are well prepared for it.

Recommendations

2. Examine the RLS areas that might introduce delays in the production and be prepared to apply limited usage of contingency to reduce the risk of that happening.
3. This part of the project is ready for CD-3b.

WBS 6 – PMT Procurement and Testing

Primary Writer: Mike Lindgren

Contributors: Hogan Nguyen

Findings

- The photon detection is done by a 64 channel Hamamatsu MAPMT, as has been the case in past reviews. The devices have low noise and linearity up to 100 photoelectrons. The QE is a minimum of 12% at the peak emission frequency of the WLS. The PMT high voltage is provided by an individually controllable onboard Cockroft-Walton base.

- Some MAPMTs have been successfully aligned and fixed in their mounts using the production alignment station and a finalized alignment procedure.

- The first 100 MAPMTs, which are for the Tracking Prototype have arrived, 50 in April, and 50 in June.

- The cost estimate for the MAPMTs is $35K lower than in the baseline, based on a recent quote from the vendor of ~$1784/tube in quantities of 200-499.

- Risk mitigation for the Tracking Prototype is done by decreasing the scope of MAPMT testing.

- We did not examine the light injection system.

Comments

- This is a standard MAPMT, and the project team has the first 100 tubes in hand. There should be no problem in delivering them to the box production factories in a timely manner, and the plan to reduce the testing scope if needed to meet the schedule introduces very little technical risk.

Recommendations

4. This part of the project is ready for CD-3b.

WBS 7 – Electronics and DAQ

Primary Writer: Hogan Nguyen

Contributor: Mike Lindgren

Findings

- The FESB now serve 10 PMT boxes, instead of 1.
- The DAQ have been delivered for the Vertical Test Stand (VTS). DAQ's are also needed for the Module Mapper, the PMT Teststand, the Tracking Prototype (TP), and the final detector. The Module Mapper DAQ is working.
- These tasks feeds into tasks that are on or near the critical path for the project (e.g. transition board delivery to PMT box production at Rutgers/Tufts, DAQ for PMT Teststand).

Comments

- The project team continues to make good progress in this area. The CW base, transition board designs are final and are ready to go for bid. These components are needed for the PMT boxes. They are not a concern for PMT box production.
- The prototype FEB has achieved good noise performance, showing good separation between the pedestal and single p.e. peaks. The design is almost final. The FESB design has just started, but not needed until April 08 for the TP.
- The 5 DAQ's are essentially identical except that the TP and VTS trigger on cosmics. The PMT Teststand DAQ is on schedule to be delivered to WBS 6 at the end of June 07. The collaboration should be able to meet that goal.

Recommendations

5. This part of the project is ready for CD-3b..

2.3 Plane Assembly, Outer Detector Frame, Absorbers, Stand and Module Assembly (WBS 3, 8 & 9)

WBS 3 – Scintillator Plane Assembly

Primary Writer: Mike Crisler

Findings

- The procedures, tooling, fixtures, and techniques for scintillator plane assembly have been demonstrated in the assembly of complete scintillator planes using production parts.

- Time and effort estimates for this task have been developed on the basis of the prototype assembly experience.

- Cost estimates are based on vendor quotes and actual procurement experience.

- Small details such as the final stack-up thickness of the scintillator planes have been precisely established using final assembly techniques with production parts.

Comments

- The estimates of cost, schedule, and effort are soundly based on actual experience and should be very reliable.

- The decision to increase the thickness of the steel absorber plates to compensate for the slightly larger than anticipated scintillator stack-up thickness is technically sound.

- The scintillator plane assembly lines are ready to proceed.

Recommendations

- None

WBS 8 – Frame Absorbers & Stand

Primary Writer: Mike Crisler

Findings

- Designs are complete for the absorbers and stand.
- A full module prototype has been completed which demonstrates the successful integration of the scintillator planes, absorber parts, and support stand.
- Cost, schedule, and effort estimates are based on actual experience with the prototype assembly.
- The support stand used in the full module prototype test differs slightly from the final support stand design.

Comments

- Based on experience with the full module prototype, the initial support stand design was found not to provide sufficient access to all of the module connections. A straightforward modification to the main support beams has addressed this access issue while maintaining the overall mechanical support capability of the stand.
- The designs are technically sound, well prototyped, and ready to proceed.

Recommendations

- None

WBS 9 – Module & Veto Wall Assembly

Primary Writer: Mike Crisler

Findings

- The assembly of a complete, fully integrated module sitting on a prototype support stand has been fully demonstrated in the Wide Band Laboratory at Fermilab.

Comments

- The designs are technically sound, well prototyped, and are ready to proceed.

Recommendations

- None.

3.0 Project Management

3.1 Cost (WBS 10)

Primary Writer: Marc Kaducak

Contributors: Dean Hoffer

Findings

- The team presented to the committee their cost estimates for each subtask and a level 2 WBS rollup. Presentations were given from each subtask based on their own work scope. The total project cost estimate including contingencies, escalation, and burdens was presented as $16.55M, not including activities funded by an NSF MRI (Major Research Instrument) grant, and not including installation and commissioning at Fermilab. Total MIE was presented as $10.7M and Total OPC (R&D) as $5.85M.

- The project presented Basis of Estimate(BOE) documents in a binder. BOE documents are also available in the DocDB system online and cross referenced from the WBS Dictionary. BOE forms are prepared for each task with a base cost over $10k. Calculation of contingencies follows from the preparation of BOEs using a weighted system based on technical, design, cost, and schedule risks.

- The net changes in the base costs from the CD1/2/3a review are a $90k increase in MIE and a $34k decrease in R&D.

- The funding profile for MIE was $5.4M in 2008, $4.9M in 2009, and $0.4M in 2010. The funding profile for R&D was $0.8M in 2006, $4.4M in 2007, and $0.65 in 2008.

Comments

- The TPC of $16.55M presented differs from that of $16.8M presented at the DOE CD-1/2/3a review. The committee felt that the TPC should be reconciled to match that presented at the DOE review.

- The project has gained valuable experience and has refined some costs following the prototyping, design refinement, and new vendor communications that have occurred since the last review. Change requests for all items contributing to these cost changes are planned to be processed following this review.

- The only significant cost risk identified at this review was the labor cost of producing the clear fiber cables. Since the design is being reworked, these costs are not fully understood although the perceived risk to the project is low.

- The system used for calculating contingencies is very systematic, providing confidence in the amounts yielded.

- Contingency usage has been commendably small.

- As mentioned in the following schedule section, the project includes several near critical path tasks. If a critical path or near critical path task poses a risk to the project schedule, additional costs may need to be allocated for additional resources required to complete these tasks on schedule.

Recommendations

6. Reconcile the current TPC to be consistent with the TPC presented at the DOE CD-1/2/3a review, perhaps by adjusting the R&D funding profile.

7. Follow through with change requests on known cost changes such as the increased wastage in ODU fabrication, electronics design refinements, and the updated PMT quotation.

3.2 Schedule

Primary Writer: Dean Hoffer

Contributors: Marc Kaducak

Findings

- Schedule contingency has been reduced greatly for the R&D milestones because of a combination of technical issues, continuing resolution and reduced funding in FY2007.

- The current critical path is the same as presented at the DOE baseline review, but because of slippage of R&D activities there are more activities that are near critical path.

- The MINERvA schedule is in Microsoft Project (MSP) and consists of 1138 lines. There are 685 activities for the work included in the Total Project Cost (TPC) and a total of 123 milestones. The schedule included status through the end of May 2007.

- Out of the 123 milestones there are 36 milestones that they have baseline finish dates prior to the end of May 2007, which is the last schedule status date. There are 26 milestones complete and 10 still open.

Comments

- The schedule structure/mechanics has improved since the Director's CD-2/3a review. This includes appropriate utilization of predecessor/successors and minimization of the use of constraint dates.

- There were a few of the Level-4 milestones with the projected finish dates that were past due at the time of the May schedule update. The projected finish dates have been revised at least once since they were later than the original baseline date. The finish dates of activities that drive the milestone finish dates should be updated with new projected finish dates if the existing finish dates are going to be missed. By updating the working schedule with a new projected completion date, the schedule can be analyzed to determine the impact to the successor activities and milestones, which may impact Level 3 or higher milestones that could require change control.

- Since the schedule contingency on the R&D milestones has been greatly reduced and more activities are near critical path, MINERvA's project management should actively look for opportunities to regain schedule contingency to help minimize risk.

Recommendations

8. MINERvA should update their working schedule to reflect current projected finish dates and analyze the impact to the baseline finish dates for all levels of

milestones to determine if any corrective actions are required, including initiating change control. This procedure should be implemented in the monthly schedule updates.

3.3 Management

Primary Writer: Elaine McCluskey

Contributors: Dean Hoffer, Ed Temple

Findings

- The project has been utilizing the project management tools that were set in place at CD-2, including monthly reporting, change control, project management group meetings, and other project coordination meetings and reviews.

- The documents required for the CD-3b review have been prepared and were available to the review committee via the project review website, MINERvA docdb, and memory sticks. This included all items listed in 413.3-1, CD-3 Review Criteria, plus a CD-3b Scorecard, which indicated how the project has met the CD-3b documentation requirements, and which has links to these documents.

- Five change requests have been processed to date, using the project's change control procedures and guidelines.

Comments

- The Project Manager has expressed a concern for the lack of a Fermilab-based deputy project manager to assist especially when the project manager is absent. The review committee acknowledges this need and encourages the support of the PPD managers to find a candidate as soon as possible.

- The project is to be commended for the management structures that are in place and functioning. A few additions to the project manager's toolbox that could be of use would be a change control log to summarize all project change requests and changes pages in documents such as the PMP and PEP to easily see documented changes to these since the original approval.

- The project has created a Construction Management Plan to meet the CD-3b requirement for a Construction Planning Document. This document covers the work of the MIE scope, but also includes some of the installation of the detector. For completeness the project should consider including WBS 11 Infrastructure and WBS 12 Helium Target.

Recommendations

9. The project manager should adding reporting of actual/estimated costs against the plan at WBS L2 to the monthly report and at the PMG, to parallel the more detailed schedule and milestone variance reports already being done.

4.0 Charge Questions

4.1 Are the project's cost, schedule, and technical baselines appropriate and consistent with those approved in March 2007? Is there adequate progress to meet the baseline objectives?

Yes. The Project is using the standard project management tools in an effective and appropriate way for a project of this scope. The project baseline has not changed, and the project manager is has worked to minimize the effect of the CR. That CR has caused the project to use some schedule contingency. Additional delays in the receipt of funding could result in the need to change some baseline milestones.

4.2 Are the designs of the technical systems sufficiently mature to support the hardware procurements planned in FY 2008?

Yes

4.3 Is there adequate contingency (cost and schedule) to address the risks inherent in the remaining work and is it being properly managed? Is the contingency supported by and consistent with an appropriate project-wide risk analysis?

The committee felt that the cost contingency is sufficient for the known risks and is being managed well. It is expected that known cost changes will be processed via change requests shortly following this review. Many tasks have incurred a reduced amount of available schedule contingency, largely due to the late arrival of R&D funds and a few partly due to technical problems. However, the committee felt that the delays to date could be absorbed and that L2 milestones should still be met, although the project should identify opportunities to regain the schedule contingency should the need arise. Calculation of contingency is supported by BOEs, in which risk is evaluated on a task-by-task basis for all tasks over $10k.

4.4 Is the project being managed (e.g., properly organized, adequately staffed) as needed to proceed with construction? Is there adequate support from Fermilab and the MINERvA collaborating institutions to proceed with construction?

There appears to be adequate resources to proceed with construction, and adequate support from Fermilab and the collaborating institutions.

4.5 Has the project responded appropriately to recommendations from prior DOE/SC and Fermilab Director's Reviews?

All recommendations from prior reviews have been addressed and documented.

4.6 Are ES&H aspects being properly addressed?

The project has done an excellent job of identifying, tracking, and addressing the ES&H issues associated with all aspects of the parts fabrication, assembly, and installation of the detector. Based on a recommendation from a previous review panel, the project has extended this to include tracking of ES&H issues into the assembly factories in the various collaborating universities. This is a commendable practice and should be continued.

4.7 Has the MINERvA project provided satisfactory responses to the attached CD-3 "Scorecard?"

Yes, the project has provided detailed responses to the CD-3 Scorecard, including links to appropriate documentation.